

Measure Twice and Cut Once

Rushby Craig

309 Software Maintenance Group, Hill Air Force Base

This article describes how the 309th Software Maintenance Group (SMXG) at Hill AFB, Utah, used Standard Capability Maturity Model® Integration Appraisal Method for Process Improvement (SCAMPI) B appraisals as means to identify value-added process improvements, educate key project personnel in the organization on best practices, and obtain critical buy-in from project personnel within the framework of an organizational transition from use of the Capability Maturity Model (CMM) to the Capability Maturity Model Integration (CMMI) as a model of best practices. Action plans were created based on weaknesses identified in the SCAMPI B appraisals and were used to baseline and track progress on the implementation of process improvements. A series of these SCAMPI B appraisals was followed by a SCAMPI A appraisal, in June 2006, when the 309th SMXG was awarded a CMMI Maturity Level 5 rating. Details on the strategy used and lessons-learned are shared.

Anyone with experience in carpentry has at some time made a mistake and cut a piece of wood too short for its intended purpose. What happens then? After some initial words of frustration, the piece is either scrapped, saved to be used for another part that is smaller, or the finished product becomes smaller in one dimension than initially planned.

I do a little woodworking as a hobby. Over the years, my dad has been my chief mentor. One of the lessons that he taught me – which I will never forget – is to measure and mark very carefully before cutting. I have found that it is a good idea to double (or even triple) check your measurements and markings to make sure that they are correct. When I have made the mistake of cutting a piece too long, I feel fortunate because at least I get another chance to cut it correctly the second time. Often though, I make the mistake of cutting a piece too short. When this happens, my dad will repeat an old adage that is simple to remember: *Measure twice, cut once*. These words always remind me to take extra care to follow some simple practices that help me make fewer mistakes.

You might say that the same principle applies to SCAMPI A appraisals in an organization. The time, effort, and cost associated with such an appraisal are substantial. Before going through with SCAMPI A, you want to have some confidence that you will meet the goals that you have for the appraisal. You do not want to go through the trouble of preparing for and holding a SCAMPI A unless you have some confidence that the goals of the appraisal will be met. The way to do that is to measure the readiness of the organization over a period of time. There are without a doubt different ways that organizational readiness can be

measured. We as an organization thought quite a bit about how to prepare the organization for a SCAMPI A and came to some conclusions based on lessons learned from other organizations, and also from our own past experiences.

Background Why a SCAMPI A Appraisal?

So why did we decide that we wanted to have a SCAMPI A appraisal? Well, that question begs some explanation and provokes a little history lesson.

In 2002, with the Software Engineering Institute (SEI) having already announced the future sunset of the CMM and the CMM Based Assessment for Internal Process Improvement (CBA-IPI) method, the 309th SMXG made a decision to transition from the CMM to the newer CMMI model. The organization had been rated CMM Maturity Level 5 in 1998, and it was time to have a formal re-appraisal with the CMM. But rather than making a substantial investment in a CBA-IPI and then moving on to the CMMI, it was decided that the organizational strategy would be to transition to the new model with the goal of achieving Level 5 in a couple of years.

As an organization, the SMXG has a set of strategic plans and goals that have been established by our senior management with widespread input from below. One of the goals established was for the organization to be appraised at Maturity Level 5 in the CMMI. This goal was linked to several other goals in areas such as improvement in cost and schedule performance, quality improvement, organizational growth, business development, facilities expansion and improvement, etc. For them, maintaining Maturity Level 5 was a strategic investment because it ensured that they were following recog-

nized best practices, that they were continuously focusing on improvement, and that their current and potential customers could have confidence that projects will be planned, executed, and monitored properly.

Transitioning to the CMMI

The transition plan from CMM to the CMMI for the organization was mapped out into three phases: Organization Documentation and Implementation, Product-Line Documentation and Implementation, and Appraise Maturity (see Figure 1).

Phase I: Organization Documentation and Implementation

The goal of this first phase was to do the following: Review the current policy, plans, and processes used within the organization to determine where changes needed to be made to ensure compliance with the CMMI; update the applicable documents as necessary; and ensure implementation at the organization level.

Process Action Teams (PATs) were established and worked for approximately eight months, defining issues and finding solutions. The decision to use PATs was made in order to get involvement and buy-in to the needed changes from a broad cross-section of the organization. Four PATs were created, one for each category of Process Areas (PAs) in the CMMI: Process Management, Project Management, Engineering, and Support. These categories (used in the continuous representation of the CMMI) were convenient for partitioning the work that needed to be done by the PATs because of the common themes and threads within each set of PAs (even though they were using the staged representation). Each PAT had between six and 10 people

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assigned from the ranks of projects, quality assurance (QA), the Software Engineering Process Group (SEPG), and management. All of these personnel were working on this task part-time, in addition to their regular duties. At the conclusion of this phase, the PATs submitted change proposals to the executive board of the organization for approval before implementation. The executive board and their technical advisors were responsible to ensure that recommendations and approaches were sound and consistent and to give final approval for implementation. Where conflicts existed between the recommendations of the PATs or changes were not accepted, the PATs were given assignments to work out these issues. Correction of these conflicts spanned nearly two months.

Phase 2: Product-Line Documentation and Implementation

Once organization-level policies and processes were in place, they needed to be implemented at the product line and project level. This phase was similar in many ways to Phase 1 except for the level at which implementation was focused. PATs were established in the product lines and included individuals who had participated in defining policy and processes at the organizational level in Phase 1. This ensured that the people who represented the product line in the organizational-level PATs were there to assist the product-line PATs in interpreting the changes.

The product-line PATs had to review their processes to find where gaps had been created by changes at the higher level, to find solutions to the gaps in the context of their business environment, to implement these in their processes, and to train their personnel on the changes. In many ways, this proved to be more difficult than the prior phase because it is usually at this level that the *rubber meets the road*, so processes had to be written and packaged in a way that made sense in the product lines. It was also more difficult to implement practices at this level because of the large numbers of people that had to train on, had to buy into, and had to start following these practices.

Phase 3: Appraise Maturity

In this phase, the goals were to accomplish the following:

1. Look closely at what had been implemented, make some judgments about how well the organization was satisfying CMMI practices, and provide some feedback to the organization that could be used to make correc-

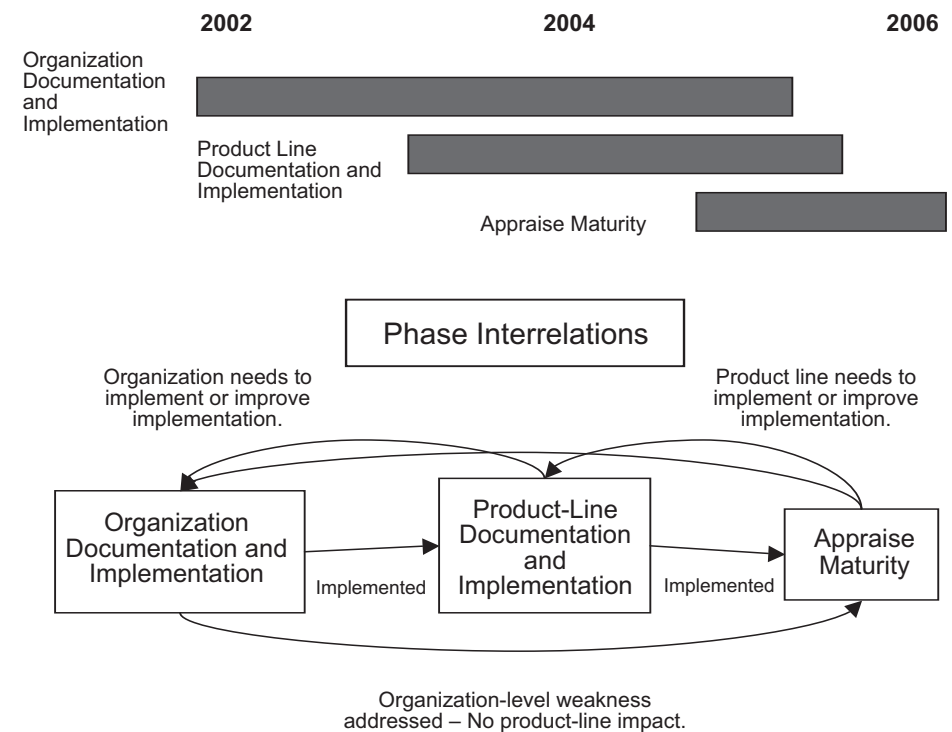


Figure 1: CMM to CMMI Transition Strategy

tions where practices were not implemented sufficiently.

2. When ready, hold a formal appraisal where rating of a maturity level in the CMMI could be made. The tools we decided to use to meet these goals were a series of SCAMPI B appraisals, followed by a SCAMPI A appraisal.

Within this phase, they implemented a plan for how the appraisals would be structured. You could say that the Appraise Maturity phase was made up of three rounds of appraisals. The first round was to use the SCAMPI B method and was intended to baseline where the organization and the projects being looked at were at that point in time. It provided a basis for the initial action plans. The second round of appraisals was also to use SCAMPI Bs, but this round was intended to measure, in an appraisal environment, how much improvement had taken place at approximately the mid-point of the Appraise Maturity phase. The third round in this phase was the SCAMPI A appraisal.

The SMXG decided to select a number of projects that would represent the organization well in terms of workload performed and in terms of numbers of people assigned to them. Other projects in the organization that were not included in the SCAMPI B appraisals were not ignored. They were expected to implement the same changes as projects involved in the appraisals; the mechanism being used to monitor their progress was

done using our standard internal QA audit function.

After much thought and discussion, they settled on six projects to participate in the SCAMPI Bs. The projects included in these appraisals were typically the larger and most mainstream in the organization. The same set of six projects was to be examined in both of the first two appraisal rounds.

Overlapping Phases

The three phases of the transition strategy overlapped each other as shown in Figure 1. The phases were not a true waterfall model where each phase would be completed before moving on to the next one. When the product lines started tailoring their processes to be compliant with new policy and organizational-level processes, it sometimes pointed out problems with these higher-level documents that needed to be addressed. This required that activities be done in Phase 1 again. Likewise, when appraisals were performed, it pointed out cases where organization, product line, or project approaches or documents were deficient and needed correction, and required re-entry into the prior two phases.

Collaborative Approach to SCAMPI B

A couple of years before the expected date of the SCAMPI A appraisal, the SMXG selected a lead appraiser and began to talk with him. The lead apprais-

er who they chose was Dr. Miluk from the SEI. In the initial discussions, Miluk told them about some recent experiences leading what he called *collaborative* SCAMPI B appraisals with organizations within some large corporations in the defense and commercial communications industries, as well as with the SMXG's sister organization at Warner-Robins Air Logistics Center, the 402d SMXG. He told us how this new approach to SCAMPI B appraisals had worked well to not only identify areas of strength and weakness with respect to the model, but had also benefited the organization in other ways. Having had much experience in CMM and CMMI appraisals in the past themselves, they knew, like Miluk, that the appraisal results often are pretty clear to the SEPG and others well initiated in process improvement but are often confusing to lay people. Miluk explained that this new approach helps in several ways, including the following: provides projects with a better understanding of what the model is asking them to do; makes it more clear to projects what their weaknesses are and how to fix them; receives buy-in from key project personnel that weaknesses identified in the appraisal were valid. After much thought and discussion with senior management, they decided to go ahead and implement this approach.

Because they were going to be conducting a string of SCAMPI B appraisals over a period of 12-18 months, and since they had a number of authorized SCAMPI lead appraisers within the organization, they asked Miluk to lead the first SCAMPI B appraisal to train them on the collaborative approach. From there, they had resources available internally to lead the rest of the SCAMPI Bs.

Project and Organization Focused Mini-Teams

In SCAMPI appraisals, the work of examining artifacts and the responsibility of making preliminary judgments about the degree of CMMI model compliance is typically distributed among groups of two or three appraisal team members. These groups of appraisal team members are called mini-teams. The use of mini-teams allows for increased efficiency in the appraisal process.

One of the most important elements in the design of their collaborative SCAMPI B appraisals was to align the mini-teams primarily by project and to make sure that key project personnel were included in the mini-team looking at their project. Because a whole series of

appraisals were happening in a relatively short period of time, there was no need to include organizationally focused PAs from the CMMI in all of the appraisals. This inclusion would have resulted in unnecessary appraisal redundancy; these PAs were examined in just two of the SCAMPI Bs. In these two particular SCAMPI Bs, they had a single mini-team focused on these PAs (e.g. Organizational Process Focus, Organizational Process Definition, Organizational Training etc.). The number of projects examined in each SCAMPI B varied, with the maximum being three projects plus the organization-level processes totaling four mini-teams.

Competencies

In determining the appraisal team members, the following three critical competencies were required for each mini-team:

1. **Project knowledge.** It was important to have someone on each mini-team who knew where to look for

The use of mini-teams allows for increased efficiency in the appraisal process.

necessary artifacts when the provided ones were insufficient. Additionally, they wanted to have someone there who could explain in finer detail, if needed, the explanation for each practice provided in the program independent interfaces (PIIs). This competency was met using the project manager (PM) or a project lead engineer.

2. **Process improvement experience in the organization.** The importance of this competency is in maximizing buy-in to the appraisal findings. In the organization, the lead process improvement agents in the product lines are called Senior Technical Program Managers (TPMs). They are skilled, experienced PMs who have responsibility to mentor and assist the managers of projects within their product lines, along with leading process improvement efforts at that level of the organization. The SMXG decided to use these individuals to help meet this competency level because they knew that having their support was essential and that making them part of the teams

on these SCAMPI B appraisals would help to ensure ownership of the appraisal findings and actions needed to address them.

3. **Appraisal and CMMI model expertise.** Each mini-team had an individual who was either a lead appraiser or had significant experience in appraisals, as well as interpreting and implementing the CMMI. This competency was addressed by using individuals who were members of the SEPG (who are lead appraisers), the internal QA group, or lead appraisers from the Software Technology Support Center (STSC).

Project-Focused Draft and Final Findings Briefings

Another important feature in the design of the collaborative SCAMPI Bs was to provide draft and final findings briefings at the project level to make sure identified weaknesses were clearly understood. The project leaders included in the appraisal team were given a conspicuous role in briefing the results of their projects as a means to add legitimacy to the findings and to help secure buy-in. In some cases, the appraisal team members representing the project were the presenters in the findings briefings. Where necessary, these individuals could explain to personnel from their own projects what the weaknesses meant, could discuss why correcting these weaknesses would add value to the project, and also could discuss with the PM ways to address and correct the issue.

After Each Appraisal

Now that a particular SCAMPI B appraisal was over, the real work of addressing issues and implementing changes was about to begin. One of the things that made our efforts to reach CMMI Level 5 more difficult than for other organizations was our size and relative diversity in our product line make-up.

This made our action planning and tracking of these plans critical. In our case, the implementation effort was focused more at the lower levels of the organization (product line and project levels) where more of our weaknesses were. The real challenge at the organization level was making sure that action plans were complete and were monitored to ensure that items would be completed in order to meet our timeframe goals for the SCAMPI A appraisal.

Action Planning

Plans for addressing appraisal weaknesses were created at the product-line level, and

also by the SEPG for organization-level weaknesses. These plans were then brought together at the organization level to provide an opportunity for review by all of the stakeholders. The plans included a work breakdown structure of tasks, personnel and resources assigned to each, effort estimates, schedules, risks (and mitigation plans), etc.

Tracking Progress

In tracking progress of the action plans, they used the following four types of charts: 1) action plan activity descriptions, 2) Gantt charts, 3) percent complete charts, and 4) charts that showed our current estimated risk of satisfying each practice in the CMMI based on the characterizations used in SCAMPI B appraisals (High [Red], Medium [Yellow], Low [Green]) as shown in Figure 2. After a short time, chart type 4 was given the moniker *The Red-Green chart* after the character from the Canadian television show (*The Red Green Show*) that is shown here in the U.S. on the Public Broadcasting Service. These were briefed every two weeks to senior management and provided them with detailed information about what issues were being worked and were scheduled to be worked, problems that were being encountered, and how well the tasks were being completed compared to the schedule.

In order to change the risk characterization on any practice on the *Red-Green* chart, a project had to have their remedy to the identified weakness reviewed by the SEPG (who have extensive CMMI model interpretation and appraisal experience) as a QA check. Only actions that could show artifacts which satisfied a particular practice were accepted toward changing a Red (High risk) or Yellow (Medium) to Green (Low). A partial solution to a weakness would permit a change in the *Red-Green* chart from Red to Yellow.

The SCAMPI A

The organization had made a goal to hold the SCAMPI A appraisal late in 2005. This goal proved to be a bit too aggressive. Some funding constraints were levied on them from the Air Force in mid-2005 that limited their ability for Process Action Teams (PATs) to function at the pace required to address all the issues that needed to be solved in that timeframe. So, the goal for holding the SCAMPI A was pushed back to June 2006. That proved to be a good thing in the end because it provided more time to do things right and to institutionalize changes. It also made efforts to prepare

for the SCAMPI A a lot less pressured than if we had continued the march toward the original goal.

The SCAMPI A appraisal was performed according to requirements of the method. Some of the choices that we made in executing the appraisal were the following:

1. **Selection of focus projects.** Focus projects were chosen from each of the product lines in the organization. Projects chosen were representative of the majority of work performed in the product lines and represented 41 percent of the engineering personnel in the entire 309th SMXG.
2. **Appraisal team size and membership.** The appraisal team had 12 members with three members per mini-team. This is probably larger than the average for a SCAMPI A appraisal. The lead appraiser assigned a representative from each of the organization's product lines, a person with lead appraiser credentials – or a very experienced appraisal veteran – and an individual from an outside government organization with high-maturity experience to each mini-team.

The members of the appraisal team from outside the organization were involved in one of the earlier SCAMPI B appraisals. This helped them to come up-to-speed on the structure of the organization and its product lines, and it familiarized them with some of the types of projects that exist in 309 SMXG and the processes used.

3. **An expanded readiness review.** A readiness review was held approximately four weeks prior to the planned start of the on-site period. The SCAMPI A method requires that the readiness review includes a review

of the artifacts (or PIIs) and the plans to make sure that these are in order and that the appraisal has a reasonable-to-high probability of being completed according to plan. The readiness review included these activities but in addition, a very detailed examination of the artifacts was performed. The readiness review lasted five full days and included some method training and a full review of artifacts in the PIIs where preliminary characterizations were made on the instantiations examined. At the conclusion of the readiness review, the appraisal sponsor was given a list of additional information and artifacts needed along with the lead appraiser's assessment of the readiness to proceed to the on-site. The green light to proceed was given.

4. **Mini-team organization.** Mini-teams were assigned to examine all the non-organizational project-oriented PAs for a particular project, as had been done in the prior SCAMPI Bs. They found that for this organization this was the most reasonable approach. Another mini-team was assigned to examine the PAs that had an organizational focus.
5. **Interview Sessions.** The first week of the on-site period was spent entirely on briefings, interview sessions with the focus projects, tool demonstrations, and additional method training (where needed). During the early part of the second week, another set of interview sessions was held with functional representatives of a much wider group of additional projects. This was done to enrich the sampling within the organization to ensure consistency and institutionalization of CMMI model practices.

Figure 2: *Red-Green Chart Example*

General Goal 2	OPD	OT	IPM	RSKM	IT	OID
GP 2.1	L		L	L		L
GP 2.2	L		L	L		L
GP 2.3	L		L	L		L
GP 2.4	L		L	L		L
GP 2.5	L		L	M		H
GP 2.6	L		L	L		L
GP 2.7	L		L	L		L
GP 2.8	L		L	L		L
GP 2.9	L		L	L		L
GP 2.10	L		L	L		L
General Goal 3	OPD	OT	IPM	RSKM	IT	OID
GP 3.1	L		L	L		L
GP 3.2	L		L	L		L

Lessons Learned

The collaborative approach to SCAMPI B appraisals was very effective for the SMXG. It met the expectations that they had in terms of improving the ability of the appraisal team to find appropriate artifacts when the PIIs provided were less than perfect. This approach also improved buy-in to the weaknesses identified in the appraisals. The use of project leaders on mini-teams improved the ability of the project leadership to understand the concepts behind model practices and facilitated their commitment to implementing value-added improvements to address these weaknesses. As an organization, they have some experience using informal appraisals to prepare for formal appraisals or in piloting new models and definitely feel that this strategy works and this approach will be used again in the future.

The management of action plans using Gantt, Percent-Complete, and Red-Green charts in concert with Current Activity description slides was critical for SMXG in getting this large effort completed. Had it not been for the clear measures and frequent reporting, the goal of achieving CMMI Level 5 would not have been met, at least not in the timeframe that they had in mind.

The SMXG found that it was critical to have QA on the closeout of action items, and the changing of risk characterizations that were represented on the Red-Green charts. Without this step, they would cer-

tainly have had some things that were thought to be sufficiently addressed that would have come back again as a weakness in a subsequent appraisal.

PII preparation and maintenance through the string of appraisals that SMXG performed turned out to be a major issue. Projects who took part in the appraisals were responsible to prepare their own PIIs, and some were more efficient and skilled than others. The effort and cost of preparing PIIs was excessive through the Appraise Maturity phase. This is one area that they will be focusing some innovation on to improve efficiency and reduce cost. They have some ideas about potential tools and methods of leveraging from the internal QA audits and data mappings to help in preparing PIIs and plan to pursue these ideas over the next year or so.

Conclusion

The adoption and institutionalization of the CMMI in the 309th SMXG was a journey that lasted approximately four years. It was a goal that would not have been reached without the continual support of all levels of management and the innovation and hard work of many individuals from all levels of the organization. The collaborative appraisal concept for SCAMPI B was a critical factor in transferring understanding of CMMI practices to projects and in obtaining buy-in to implementing them in a value-added manner. ♦

About the Author



Rushby Craig is lead for the SEPG in the 309th Software Maintenance Wing, a CMMI Level 5 organization. He was a member of the CMMI model development team, and is an authorized SCAMPI lead appraiser, having either led or participated in more than 30 CMM/CMMI-based appraisals. Craig is also an authorized instructor for the SEI's Intro to CMMI course. For four years, he was an external software consultant with the STSC, assisting organizations across the U.S. in attaining their process improvement and maturity goals. Craig's other work experience includes project management, software engineering, and quality assurance. His education includes a Bachelor of Science in Electrical Engineering from the University of Utah and a Master of Science in Electrical Engineering from the Air Force Institute of Technology.

U.S. Air Force
309th SMXG
7278 4th ST
Hill AFB, UT 84056
Phone: (801) 775-2979
E-mail: rushby.craig@hill.af.mil

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